



Status of NOvA Electronics Development

----- Front End, Back End & DAQ -----

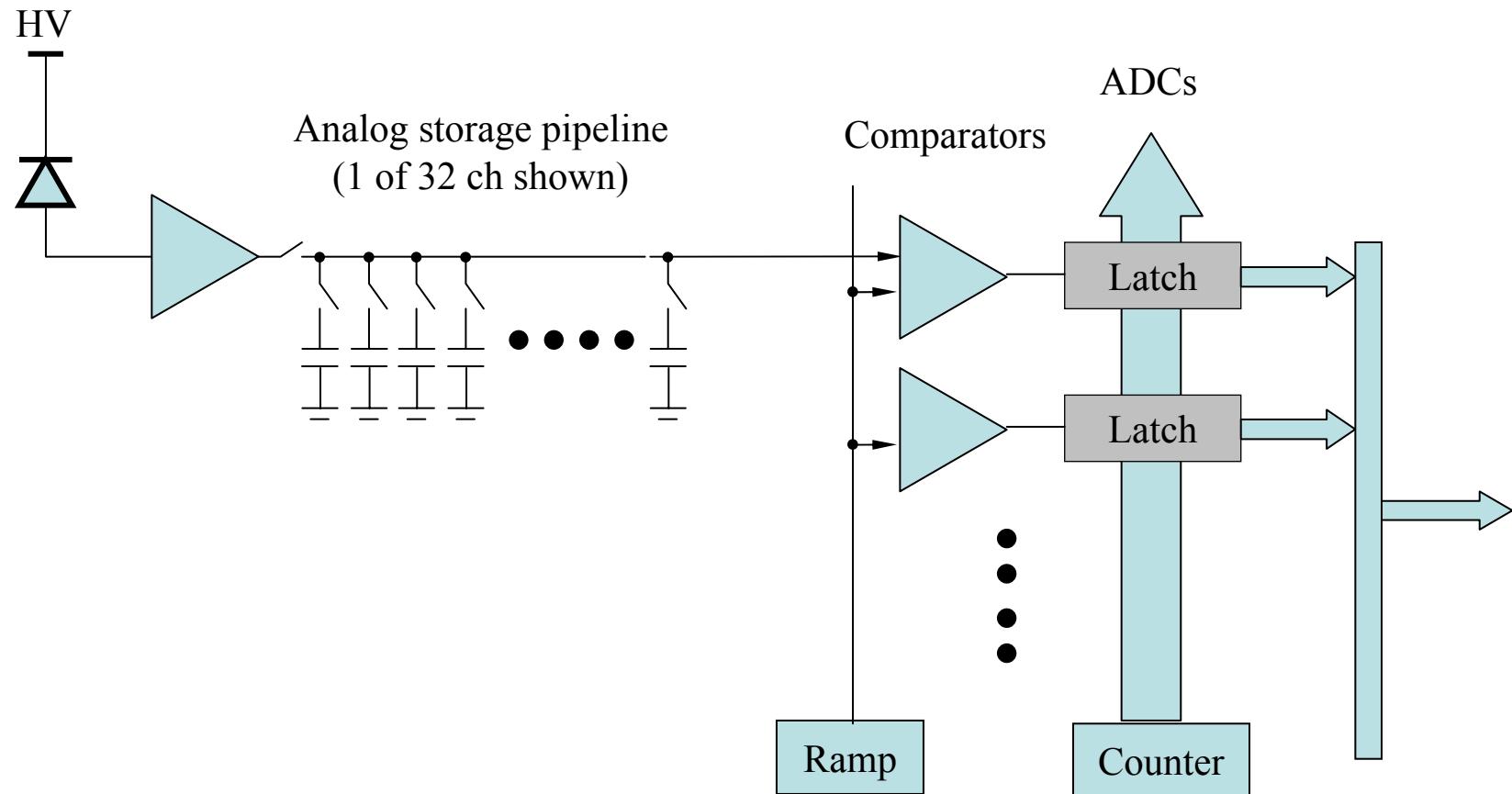
J. Oliver

Front end

- Successful prototype testing with MASDA chip
- Next generation NOvA specific **ASIC** under development @ Fermilab (Tom Z, Ray Y)
 - Pipeline option
 - Multiplexer option

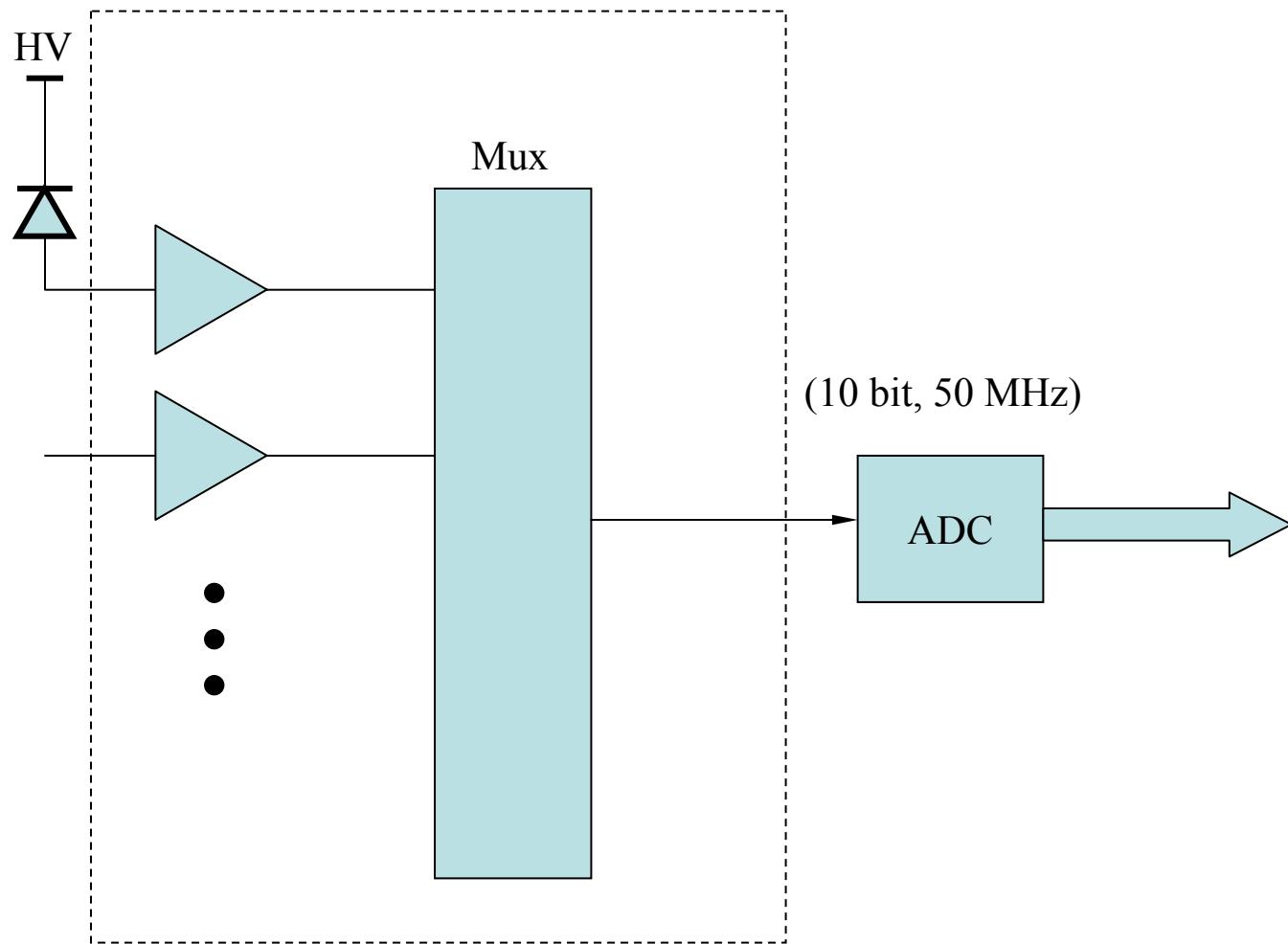


Pipeline option





Multiplexer option





Features, comparisons, and development plans

- Pipeline
 - Readout triggered by NUMI timing signal (normal mode)
 - No external ADC
 - Inter-spill readout possible using higher speed, multi-slope ramp generator
 - Different operational modes & calibration constants in-spill and inter-spill
- Multiplexer option
 - Continuous single mode readout
 - External ADCs required
 - NUMI timing trigger not required at Front End level
 - Prototype testing in progress – Available for APD integration
- Development plans
 - Preamp/shaper stages designed and simulated (Tom Z.)
 - Pipeline stage designed (not layed out) (Tom Z.)
 - Multiplexer design/simulation work (Tom Z, John O)
 - Simultaneous (or near simultaneous) submission of two designs in TSMC 0.25u



Readout, triggering, & DAQ

- Cosmic rates, data bandwidth -

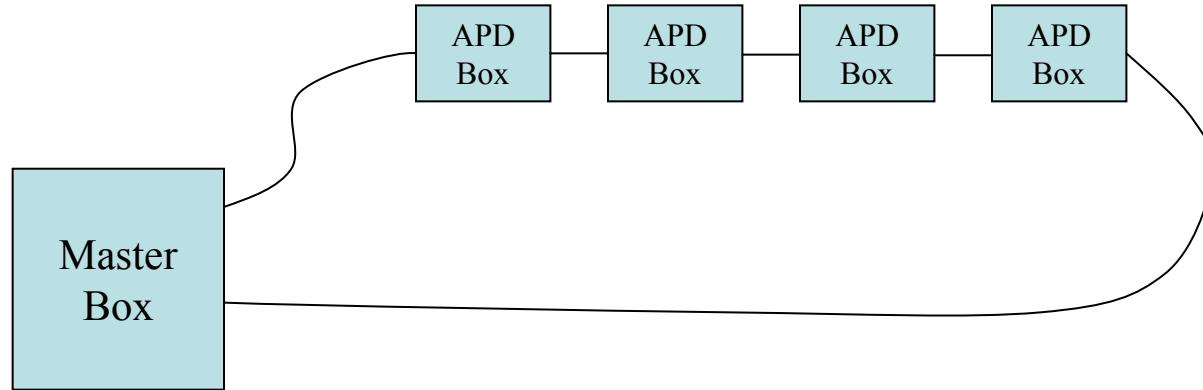
- ~ 700 Hz/pixel (Leon M) to 2,000 Hz/pixel (Alfons W.)
- Assume 8 bytes per hit → Pulse height, time stamp, address
- 32 channels per APD box → 500kB/s (~ 5 Mb/s) raw data rate
(i.e. un-triggered)



Readout, triggering, & DAQ

- Readout architectures -

- Ring – (Weber/Nicholls)

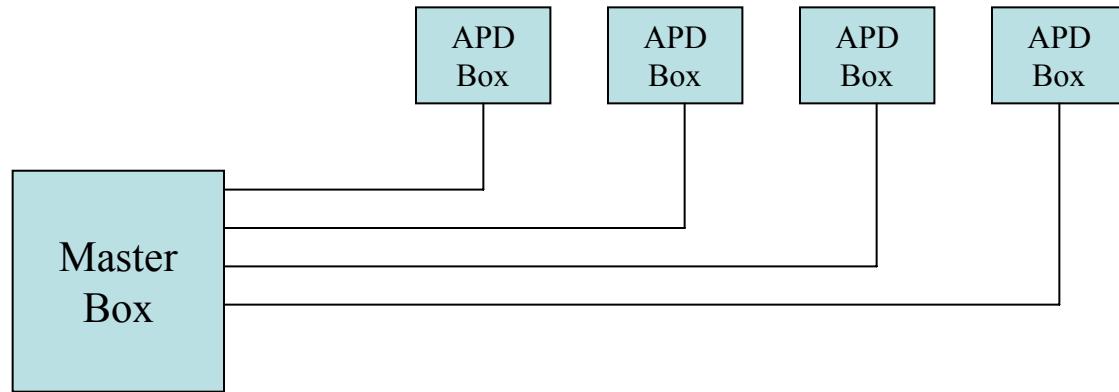




Readout, triggering, & DAQ

- Readout architectures -

- Star -

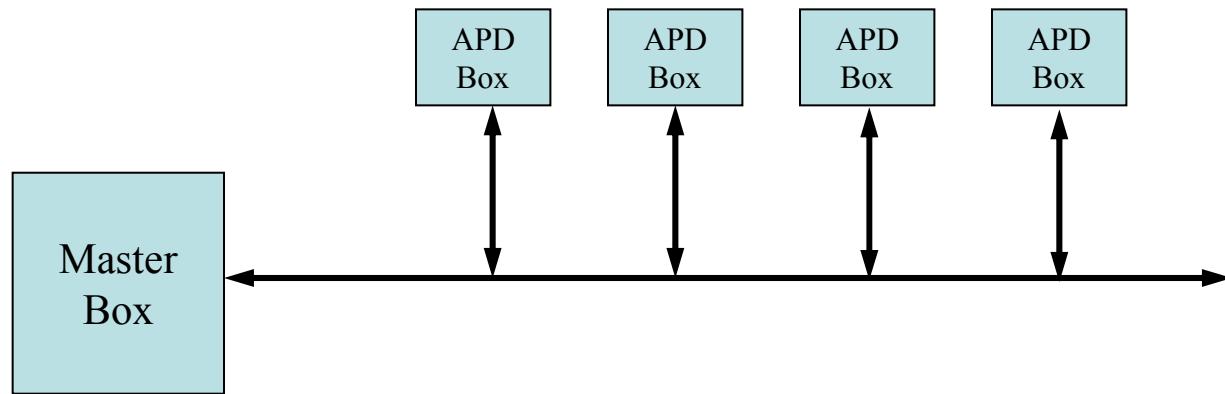




Readout, triggering, & DAQ

- Readout architectures -

- Bus -





Readout, triggering, & DAQ

- Readout architectures -

Architecture features

- All : Trigger opportunities in Master Box?
- Ring
 - Can use standard protocols; e.g. Ethernet, or other standard serial.
 - Redundant communication path. Survives one dead APD box
(Is this important?)
 - Each link must be capable of carrying bandwidth of entire ring
 - Example: 64 APD boxes → 320 Mb/s each link for continuous readout. Not an issue for beam spill triggered data only
- Star
 - Standard protocols
 - Low bandwidth local links
 - More connectors on Master box
 - Easily supports continuous readout
- Bus
 - Custom protocol – 1 or 2 bytes wide
 - Relatively low bandwidth per signal line
 - Multi-drop twisted pair cable (few cables)



Architecture issues

- Architecture needs to be ***physics driven***
- Do we want NUMI ***spill*** data only, ***all data, or somewhere in between?***
- How much data needs to be stored to media?
 - Can we make **local triggers** in the APD boxes?
 - How about in the MASTER boxes?
 - Do multiple MASTER boxes need overlapping data?
 - How do we implement a SN trigger? Do we want to?
- These are ***collaboration wide*** decisions.... we need input.
- A full Readout/Trigger/DAQ ***requirements*** document should precede and drive the design
- We will be initiating ***workshops*** on these issues and will be requesting collaboration input.
- Last but not least: ***Will there be an overburden?*** → A good trigger system can get rid of 90% of useless data....but so can a bulldozer.